



Development of a Commercially Viable Conversion of a Diesel Engine to a Spark Ignition Natural Gas Engine with the More Complete Expansion Cycle (MCEC)

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Objective

To develop a commercially viable kit to convert the Navistar DTA 466 diesel engine to a high-efficiency dedicated spark ignition (SI) natural gas engine.

Approach

The conversion process changes the engine cycle to a more complete expansion cycle in which the expansion



A Navistar 466 diesel engine converted to natural gas operation was installed and tested in a school bus to establish the practicality of retrofitting existing engines in the field.

ratio of the original diesel engine is unchanged while the effective compression ratio is lowered, so that engine detonation is avoided. The converted natural gas engine, with an expansion ratio higher than that normally used for the conventional spark-ignition natural gas engine, offers thermal efficiency at wide-open-throttle conditions comparable to its diesel counterpart. This technique leaves the engine with the original diesel pistons and cylinder head and, therefore, allows field conversion of existing vehicle engines.

A Navistar DTA 466 diesel engine with an expansion ratio of 16.5 to 1 was converted using this technique. The conversion process includes modifying the cam profiles, increasing the turbocharger boost pressure, incorporating an aftercooler if it does not already exist, and adding a spark-ignition system, a natural gas fuel management system, a throttle body for load control, and an electronic engine control system. The design of the cam profile to provide the appropriate valve timing was aided by computer simulation of the intake and exhaust processes. The criteria for the cam design and boost pressure requirement were based on the desired engine output and detonation-free operation.



Accomplishments

A proof-of-concept engine converted from a Navistar DTA 466 engine was used successfully to demonstrate the technical feasibility of the concept. After the completion of the proof-of-concept engine testing, a conversion system was developed for the Navistar DTA 466 engine. The system was designed for stoichiometric operation of the engine, together with a three-way catalyst for emissions control. Steady-state testing of the engine at full load and variable speeds showed expected power output and fuel consumption. NO_x emissions on the order of 1.5 gm/bhp-hr have been measured at full-load conditions.

The conversion system was installed on a school bus to establish the practicality of retrofitting existing engines in the field. The school bus was used to calibrate the PCM for driveability. A 3700-mile cross-country field test has been completed to obtain durability data for the various engine components. Valve recession rates and oil

consumption were found to be comparable to those of the conventional spark-ignition natural gas engines. Field testing of the conversion system on two trucks is presently being carried out in California.

Future Direction

The DOE-funded program has been completed. Future work includes installing conversion kits on additional vehicles for various applications and duty cycles, and then performing a field evaluation and demonstration of the converted Navistar DTA 466 engines. Emissions measurements will be made on these vehicles during the course of the field tests.

Publication

Chen, T.N., R. Mastronardi, and R. Raymond. 1994. "A New Method for the Conversion of Diesel Engines to Spark Ignition Natural Gas Engines," International Conference and Exhibition on Natural Gas Vehicles, Toronto, Ontario, Canada. October.

